**Actively exploiting quantum effects: a verge between life and (bio)molecules**

**Abstract**

Following advancements in physics and biology, the scientific community had anticipated quantum signatures generated in biological systems, posing question about their purpose on a verge between life and (bio)molecules. New possibilities opened up with fresh approaches to age-old problems in the molecular and material sciences as more advanced simulations bridge this gap. Recent demonstration of a fundamental difference between classical and quantum thermodynamics in terms of calculating physical quantities, such as entropy, could pave their way to the world of quantum tunneling that leads to genetic mutations spontaneously cropping up in a single rung of the spiraling ladder of DNA or the one of the green sulfur bacteria actively exploiting quantum effects called vibronic mixing to steer the excessive energy where it can be quenched. For the first time a research team has shown that water and organic matter can evolve *in situ* on the surface of Itokawa, and likely many other asteroids in our solar system, as well as being delivered there via meteorite and space dust impacts, over aeons of celestial time. In addition, even the iconic genetic code can now be viewed as an “energy code” that evolved into a nearly uniform blueprint across all living species through self-replicating DNARNA mixes knitted together by a simple compound called diamidophosphate. Furthermore, although we still observe many gaps in the evolution of life, we see from recent studies, for example, that most of the Ediacaran animals still possessed some basic features that persist today including left-right symmetry, apoptosis, immune system, body segmentation, noncentralized nervous systems, musculature and master controllers known as high-level regulatory genes. On one hand, increasing number of evidence now support appearance of similar evolutionary patterns independently several times during evolution. On the other hand, discovery of some novel exaptations, like developing of the first bones to serve as mineral deposits or development of the neuromuscular system and pathways that controlled ancient vertebrates’ scuttle along the sea floor, change the evolutionary timeline as we knew before. All these seemingly unrelated phenomena could be the result of life actively exploiting the process of symmetry breaking, used as a conceptual tool in physics to identify subatomic particles and their properties for many decades. Based on this theoretical framework, one could identify the basic structure of symmetry breaking across biological scales, namely emergence, propagation, and cascading of symmetry breaking-induced layers across the biosphere.